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EFFECTS OF DIFFERENT TREE PACKAGES VARY WITH SPECIES AND HABITAT TYPES

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ABSTRACT

*The effects of three types of packages (polyethylene-lined kraft paper bag, 2-mil polyethylene bag inside a cardboard box, and open-end, wooden tree crate) on nursery planting stock were tested on two conifer species, lodgepole pine (*Pinus contorta *Dougl.) and ponderosa pine (*Pinus ponderosa *Laws). Crated lodgepole pine trees had highest third-year survival and most height growth for the 3-year study period. Ponderosa pine trees performed best when packaged in polyethylene-lined kraft paper bags. There is some indication that the effects of packaging diminish as handling and planting site conditions approach the optimum for each of these species.*

KEYWORDS: nursery stock, packing media, packaging

Foresters are becoming increasingly aware of the gain in survival and height growth to be expected from improving the quality of nursery stock.

Just as important as developing quality stock is the maintenance of its vigor from lifting to planting on a forest site. In central Idaho, seedlings are often planted on a site where soil moisture levels are adequate in the spring (when planting usually takes place) but decrease until the young trees are under severe stress. To survive this drought period, seedlings must be capable of initiating vigorous root growth soon after planting.

One factor that may have a pronounced effect on the maintenance of tree vigor is the type of packaging used to hold trees during handling, storage, and shipping.

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The two questions addressed in this study are:

1. Which of three packages (polyethylene-lined kraft paper bags, 2-mil polyethylene bags inside cardboard boxes, and open-end wooden tree crates) best maintains tree vigor?

2. Is a particular package best for two of the major species, lodgepole pine (*Pinus contorta* Dougl.) and ponderosa pine (*Pinus ponderosa* Laws.), grown at the Lucky Peak Nursery?

METHODS

The lodgepole pine stock was raised from seed collected in the vicinity of McCall, Idaho, on the Payette National Forest at an elevation of 1,676 to 1,829 meters. The ponderosa pine stock was raised from seed collected on the Boise National Forest at an elevation of 1,524 meters. The age class for both species was 2-0.

Seedlings of both species were lifted, sorted, packaged, and put into storage the first week of April 1972. Until planting time, they were stored at the nursery in a tree cooler where the ambient air temperature ranged from 1.1° to 3.9° C depending largely on outside temperatures.

Trees of each lot were packaged in bags, boxes, and crates on the day they were lifted. The crates were approximately 57 by 19 by 19 centimeters. A strip of Fibreen 200[2] (a waterproofed and fiber-reinforced kraft paper) was used to line each crate. A 4- to 5-centimeter layer of clean, well-moistened sphagnum covered the Fibreen 200. Then alternate layers of moss and seedlings were put into the crate until it was filled. The seedlings were placed root to root in the approximate center of the crate. A final 4- to 5-centimeter layer of moist sphagnum was placed over the roots of the top layer of seedlings and the waterproof paper was gathered at the ends and rolled tightly. The crate was closed with four wire catches.

The seedling bags used were 61- by 28- by 89-centimeter three-ply kraft paper with an inner layer of polyethylene forming the moisture barrier. Two large handfuls of well-moistened sphagnum were placed in the center bottom of each seedling bag. Tree seedlings were placed in layers with their roots over the moss. Two large handfuls of moss covered the roots of the top layer of seedlings. Each bag was closed and rolled tightly to expel the air within it. Then the rolled bag was taped with four strips of 1-inch nylon-reinforced tape.

The seedling boxes consisted of a 17.6 kilograms per square centimeter fiberboard box with a 2-mil polyethylene bag liner. Two large handfuls of well-moistened sphagnum were placed in the bottom center of the liner. Tree seedlings were placed in layers with their roots over moss. Two large handfuls of moss covered the roots of the top layer of seedlings. The liner was closed and rolled tightly to expel the air. Then the box was closed and taped shut with nylon-reinfored tape.

All trees were taken from the nursery to the field in a large cooler built for that purpose. The cooler was an insulated box (approximately 0.9 by 1.5 by 0.6 meters) with an ice retainer in one end. At the planting site, the tree packages were removed from the box and placed in the shade. The tops of the bags and boxes were opened to allow air to circulate as the temperature of the trees increased. Enough trees to plant one plot were removed as needed and placed in a canvas planting bag.

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[2] Use of trade or firm names is for reader information only, and does not constitute endorsement by the U.S. Department of Agriculture of any commercial product or service.

Study plots were established at two locations within the Boise National Forest, Idaho. One site is near Tripod Meadows on the Emmett Ranger District. The study area is on the upper edge of a frost pocket within a large clearcut that was logged in 1970. The habitat type has not been identified with certainty--the sparse understory contains *Vaccinium caespitosum* Michx., but the plots appear to be located on or close to an ecotone between grand fir (*Abies grandis* [Dougl.] Lindl.) and subalpine fir (*Abies lasiocarpa* [Hook.] Nutt.) habitat types. The study area is on a gentle, southwest-facing slope at an elevation of 1,585 meters. The second site is in the Bannock Creek drainage on the Idaho City Ranger District. This study area is within a large clearcut that was logged in 1968. The habitat type is Douglas-fir/ninebark (*Pseudotsuga menziesii/ Physocarpus malvaceus*). The plots are on a 50 percent slope facing northwest at an elevation of 1,920 meters. Dense shrub vegetation covered the area.

On each study area, five blocks, each containing six 3.4- by 1.2-meter plots, were established in late May and early June 1972. Six treatments were randomly assigned to the six plots in each block:

Species	*Package*
Lodgepole pine	Crate
Lodgepole pine	Box
Lodgepole pine	Bag
Ponderosa pine	Crate
Ponderosa pine	Box
Ponderosa pine	Bag

In each plot, 20 trees were planted in two rows of 10 trees, spaced 0.3 by 0.6 meter apart. All trees were planted in freshly dug 10- by 36-cm auger holes. Special care was taken to prevent air pockets in the planting hole. Before planting was begun, each plot was cleared to mineral soil.

The trees were planted May 26 and 27 at Tripod Meadows and June 5 at Bannock Creek. The time, air temperature, and relative humidity were noted at the time planting began in each block. At Tripod Meadows, air temperature ranged from 12.2° to 17.8° C and relative humidity from 34 to 51 percent. At Bannock Creek, temperatures were higher, ranging from 23.3° to 26.7° C and relative humidities were lower, ranging from 18 to 34 percent.

Live and dead trees were counted and the dominant leader elongation measured to the nearest centimeter at the end of each of the first three growing seasons (1972, 1973, and 1974). The results are presented as survival at the end of 3 years and as height growth for 3 years. Because the sites were widely different, the plantings on the two areas were treated as separate experiments in the statistical analyses. Analyses of variance tests were run on survival and height-growth data. Each percentage value for survival was transformed to arcsin $\sqrt{\text{percentage}}$ prior to analysis. Comparisons among treatment means were made using a sequential method (Snedecor 1956).

RESULTS

Survival.--Unless seedlings were packaged in crates, third-year survival of lodgepole pine was significantly less than that of ponderosa pine on both study areas (table 1). Survival of lodgepole pine ranged from 17 percent for boxed trees on the Bannock Creek study area to 84 percent for crated trees on the Tripod Meadows area. Survival of ponderosa pine ranged from 66 percent for crated trees to 95 percent for bagged trees; both extremes occurred on the Tripod Meadows area.

Table 1.--*Survival and height growth means and statistical significance*[1] *for lodgepole pine and ponderosa pine stored in different types of package*

Species	Package	Tripod Meadows		Bannock Creek	
		Survival	Growth	Survival	Growth
		Percent	*Cm*	*Percent*	*Cm*
Lodgepole pine	Crate	84a	24.0a	68bc	25.6a
	Box	31c	13.0c	17d	14.1c
	Bag	51b	19.1b	43c	22.2ab
Ponderosa pine	Crate	66b	11.6c	73ab	14.2c
	Box	93a	13.2c	88ab	15.9c
	Bag	95a	15.3c	92a	19.5bc

[1] Within any column those values followed by the same letter are not significantly different at the 95 percent level.

We found a significant interaction between package type and species. Survival (fig. 1) was highest for crated lodgepole pine seedlings, lowest for boxed trees, and intermediate for bagged trees. Survival of ponderosa pine was lowest for crated trees and about the same for bagged and boxed trees.

More lodgepole pine trees survived at Tripod Meadows than at Bannock Creek for all three package types. Ponderosa pine survival was about the same on both areas.

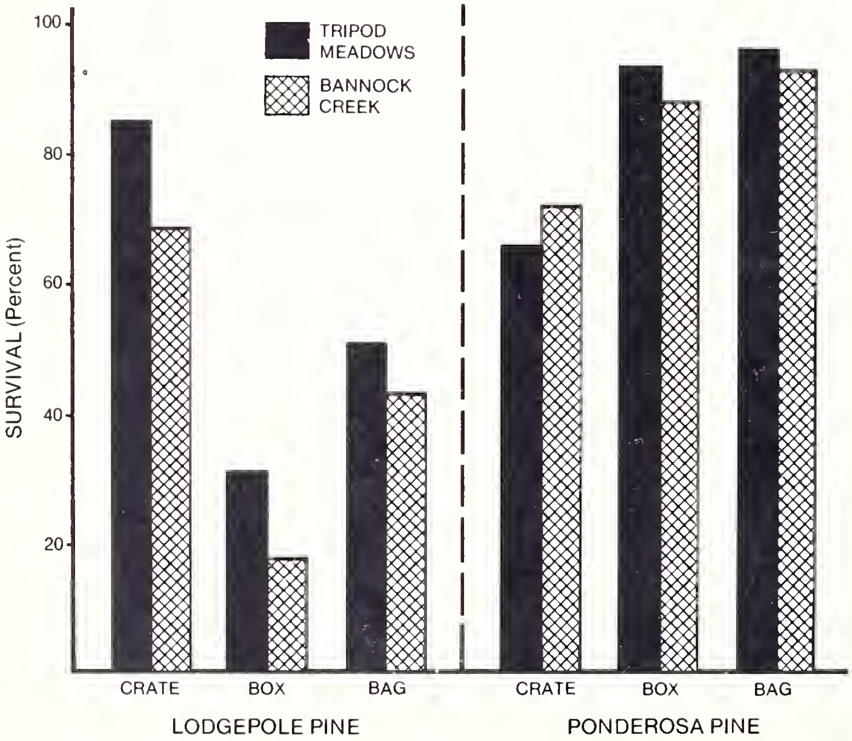
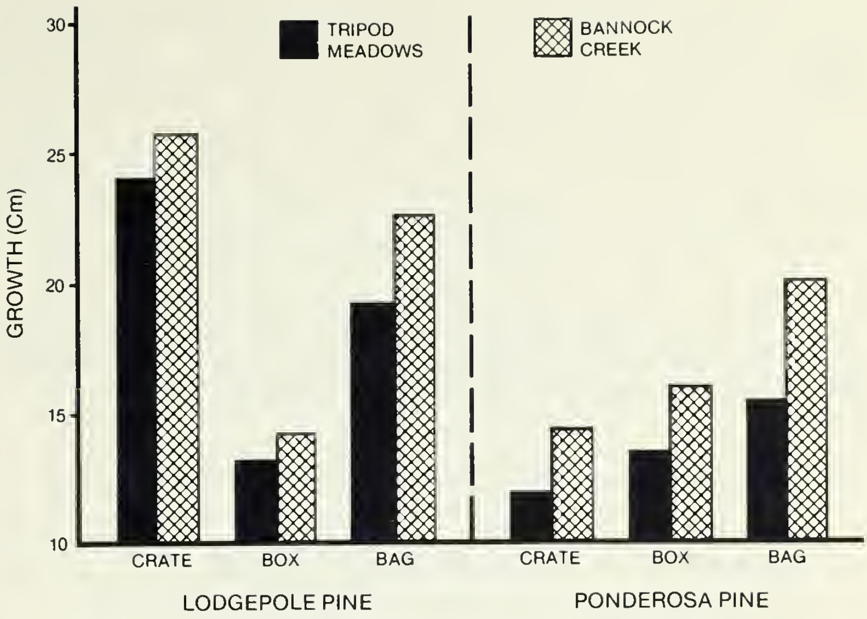


Figure 1.--Third-year survival (percent), lodgepole pine and ponderosa pine.

Figure 2.--Three-year growth of lodgepole pine and ponderosa pine.



Height growth.--As is true of survival, height growth is contingent on package type and species (fig. 2). Crated lodgepole pine trees grew more than bagged trees, which grew significantly more than boxed trees (table 1). Crated ponderosa pine trees grew the least and bagged trees the most. However, for ponderosa pine trees in different package types, none of the differences in growth were statistically significant. Trees of both species grew taller at Bannock Creek than at Tripod Meadows, regardless of packaging. Except for boxed trees, lodgepole pine seedlings grew significantly more than ponderosa pine on both study areas.

DISCUSSION AND CONCLUSIONS

Ecological evaluations of the two sites led us to believe that lodgepole pine would perform better at Tripod Meadows than at Bannock Creek and ponderosa pine would do better at Bannock Creek. Our expectations were not fully realized.

On the cold habitat of the Tripod Meadows study area, lodgepole pine is usually the only vigorous timber species found. In fact, the stand removed during logging was almost pure lodgepole. Ponderosa pine was planted offsite on this area. We expected the higher survival of lodgepole pine on this area, but the high survival of ponderosa pine was not expected. We expect the lodgepole pines to develop into well-formed mature trees, but the ponderosa pines may not.

Lodgepole pine is seldom found on the Douglas-fir/ninebark habitat type, but trees planted at Bannock Creek are growing more vigorously than the ponderosa pines.

Lodgepole pine survival is lower than that obtained in subsequent studies or that obtained by Intermountain Region planting projects over the last 3 years. The effects of the package type are also greater than in a more recent study (Morby and Ryker 1975) where each species involved was planted in a habitat where that species grows vigorously.

The poor performance of lodgepole pine could be due to one or more factors. First, the early April lifting date is late for this species. Lodgepole usually begins to break dormancy in February, according to oscilloscope readings (Ferguson and others 1975). Because of the late lifting date, lodgepole pine trees in this study were probably more active and so susceptible to damage and loss of vigor during storage in a closed container. Second, the trees were not acclimatized (Dahlgreen and others 1974). The lack of acclimatization may have affected tree performance, although the high third-year survival of ponderosa pine tends to refute this. Finally, the study reported here was conducted before the refrigeration capabilities of the storage coolers at the Lucky Peak Nursery were improved. Storage temperatures may not have been as constant as they have been since 1972; consequently, the overall vigor of the stored trees might have been reduced while the effect of package type on vigor was increased.

Possibly, the package effects of bags and crates are not significant when trees are lifted early, are properly cared for, and then are planted on sites to which the species is well adapted. However, they quickly become significant when the trees are under stress during handling or after being planted on a site that is severe for the species.

Assuming we are correct, the following recommendations are offered:

Species	*Best package*	*Acceptable package under most circumstances*
Lodgepole pine	Crate	Bag
Ponderosa pine	Bag	Box, crate

For best performance, we recommend the crate for lodgepole pine and the bag for ponderosa pine seedlings. Under optimum care and site conditions, however, either the crate or bag could be used for both species. The box could also be used for ponderosa pine, but the 2-mil polyethylene bag inside the box seemed to give less than adequate gas exchange in this study; many needles exhibited damage that appeared to result from fermentation. We are planning further tests of different types of boxes, and expect that other box designs will give better results.

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